Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

preparation, issue, and receipt to bedside verification [10]. The green colour of plasma has been reported by many authors previously both in blood donors [1,2,4,7,11] and patient population [5,12]. Although blood services have considered therapeutic use of green colour plasma still hesitancy among clinicians has been reported for clinical use as well as concerns among blood centre staff to issue [1,2,11]. The previously published reports from India had advised a word of caution for clinical use because of no national guidelines and had discarded green colour plasma [7,11].

The majority of reports of green plasma have been reported from female donors and are mostly associated with OCP use or pregnancy except reported by Pai S in a male donor [11]. Our donor, to the best of our knowledge, is the second reported male donor with green colour plasma and the first one for SDAP. However, green colour plasma has earlier been reported in therapeutic plasma exchange patients [5,12]. Our donor had high copper levels with borderline high ceruloplasmin levels. Further investigation could not be performed as the donor didn't want to investigate it though he was advised to visit a physician. We have issued the SDAP to patients considering the clinical situation requiring urgent transfusion and scarcity of SDAP donors in the current COVID-19 pandemic. The transfusion was successful, with no immediate adverse effect reported. The green plasma can be transfused after the informed joint decision of clinical & transfusion services, particularly in an emergency in the absence of national guidelines.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Elkassabany NM, Meny GM, Doria RR, Marcucci C. Green plasma-revisited. Anesthesiology 2008;108:764–5, http://dx.doi.org/10.1097/ALN.0b013e3181672668 [PMID: 18362615].

[2] Kirk FL 3rd, Bandhlish A, Arora V, Brown CH 4th. The colour of plasma. Can J Anaesth 2014;61:209–10, http://dx.doi.org/10.1007/s12630-013-0078-5 [Epub 2013 Nov 20. PMID: 24254041].

[3] Guignard J, Tissot JD, Canellini G. Unusual colours of plasma. Br J Haematol 2012;156:419, http://dx.doi.org/10.1111/j.1365-2141.2011.08930.x [Epub 2011 Nov 8. PMID: 22066786].

[4] Gorlin JB, Engblom A, Janzen M. Transfusion medicine illustrated. Green plasma in female blood donors on estrogen-containing birth control pills. Transfusion 2013;53:2122, http://dx.doi.org/10.1111/trf.12107 [PMID: 24099340].

[5] Rivera Rolon M, Pacheco DA, Bryant BJ. Red to green pigment change noted in plasma of patient undergoing therapeutic plasma exchange for Goodpasture syndrome. Transfusion 2018;58:2270–1, http://dx.doi.org/10.1111/trf.14765 [PMID: 30276851].

[6] Visual assessment guide. Professional Education; 2016 [Available from: https://professionaleducation.blood.ca/en/transfusion/best-practices/visual-assessment-guide. Last assessed September 01, 2021].

[7] Sood T, Bedi RK, Mittal K. Discolored blood and blood components: a dilemma for transfusion specialists. Transfus Apher Sci 2014;50:255–9, http://dx.doi.org/10.1016/j.transci.2014.01.011 [Epub 2014 Jan 18. PMID: 24492065].

[8] Roy A, Bagchi I, Choudhury N. Need for motivation of plateletpheresis donors: a tertiary care cancer center experience from eastern India. Ann Med Health Sci Res 2014;4:S63–4, http://dx.doi.org/10.4103/2141-9248.131725 [PMID: 25031915].

[9] Sven Ove, Hansson. Risk and safety in technology. In: Anthonie Meijers, editor. Handbook of the Philosophy of Science. North-Holland: Philosophy of Technology and Engineering Sciences; 2009. p. 1069–102 [18789846, ISBN 9780444516671].

[10] Maynard K. Administration of blood components. AABB technical manual. 18th ed. AABB, Bethesda, Maryland; 545-59.

[11] Pai S, Hasan Z, Jena M. Green colored plasma discovered in a male blood donor: a cause for concern? Glob J Transfus Med 2020;5:93–5.

[12] Bala Kumar SD, Fernando EM, Srinivasaprasad ND, Valavan KT, Sujit S. Discolouration of plasma in therapeutic plasma exchange. Indian J Nephrol 2021;31:207–8, http://dx.doi.org/10.4103/ijn.IJN_223_20 [Epub 2020 Nov 7. PMID: 34267451; PMCID: PMC8240939].

P.P. Tripathi
V. Kumawat*
A.V. Vittal
Department of Transfusion Medicine & Haematology, National institute of mental health & neurosciences, Bengaluru, India

* Corresponding author.
E-mail addresses: Paramt.cmc@gmail.com (P.P. Tripathi), kumawatdrvijay@gmail.com (V. Kumawat), dr.anchan88@gmail.com (A.V. Vittal)

https://doi.org/10.1016/j.tracli.2021.10.006

Correlation between ABO blood group and neutralizing anti-SARS-CoV-2 antibody titers in convalescent plasma donations

Many efforts have been made during the last 18 months to identify factors associated with SARS-CoV-2 antibody response in COVID-19 convalescent plasma (CCP) donors, with older age, male sex and disease severity having been identified as the main predictors [1,2]. Although the association between ABO blood type and susceptibility to COVID-19 is well known and studied [3], with individuals having O blood type being less prone to infection, there is more uncertainty regarding ABO blood group-driven SARS-CoV-2 antibody response. Hayes and colleagues [4] recently observed that blood group O CCP donors have significantly lower levels of SARS-CoV-2 IgG antibodies than do donors with other blood groups. Antibody levels were measured using a semi-quantitative chemiluminescent immunoassay as a surrogate for the traditional plaque reduction neutralization test (PRNT). To assess their findings, we studied the correlation between 496 consecutive CCP donations, given at the Transfusion Center of Mantova city hospital, and the SARS-CoV-2 neutralizing antibody titer, measured using the gold-standard PRNT (performed at the Molecular Virology Unit of the University Hospital of Pavia and based on the determination of the in vivo cytopathic effect, as previously described) [5].

The ABO blood group distribution among the study population (394 CCP donors) was the following: O = 165 (41.9%), A = 173 (43.9%), B = 36 (9.1%) and AB = 20 (5.1%). There were 319 (81.0%) male and 75 (19.0%) female CCP donors. Their mean age was 45.8 (±11.4) years. Of the 394 donors, 292 (74%) gave one CCP donation, while the remaining 102 donors made repeat CCP donations (37 gave 2 donations, 8 gave 3 donations and 1 gave 4 donations). The average time interval between recovery from symptoms and CCP donation was 39.6 (±21.1) days. No statistically significant differences in the distribution of donors' sex, donors' age and interval between symptom resolution to donation by ABO blood group was observed. At one-way analysis of variance, the ABO system did not appear to exert any significant effect on neutralizing antibody levels ($P = 0.78$). However, as reported in Table 1a, the marginal effects (i.e., the mean values of the neutralizing antibody level) appeared somewhat different, the mean titer being highest in the AB group and lowest in the O group, although the 95% confidence interval (CI) was too high to support this being of any statistical significance. Similarly, the pairwise comparisons of the marginal linear predictions were all not significant (Table 1b). Again, however, the

Table 1a
Correlation between anti-SARS-CoV-2 neutralizing antibody titer and ABO blood group, marginal linear predictions (1a) and pairwise comparisons of marginal linear predictions (1b).

			Unadjusted	
	Margin	Std. Err.	95% Conf. Interval	
ABO				
A	194.10	16.72	161.26	226.94
AB	238.08	48.29	143.19	332.96
B	192.22	36.71	120.10	264.34
O	185.10	17.07	151.55	218.64

Table 1b

					Unadjusted	
	Contrast	Std. err.	t	*P*>t	95% Conf. Interval	
ABO blood group						
AB vs A	43.98	51.10	0.86	0.390	−56.43	144.38
B vs A	−1.88	40.33	−0.05	0.963	−81.13	77.37
O vs A	−9.01	23.89	−0.38	0.706	−55.95	37.94
B vs AB	−45.85	60.66	−0.76	0.450	−165.04	73.33
O vs AB	−52.98	51.22	−1.03	0.301	−153.62	47.66
O vs B	−7.13	40.48	−0.18	0.860	−86.67	72.42

Table 2
Proportion of donations reaching the neutralizing titer ≥ 80 according to ABO blood type.

ABO	< 80	≥ 80	Total	%
A	68	149	217	68.7
AB	6	20	26	76.9
B	12	33	45	73.3
O	70	138	208	66.3
Total	156	340	496	68.5

greatest difference was between O and AB blood groups (−52.98). Interestingly, the proportion of donations reaching a high neutralizing titer (defined as ≥ 80) was lower in O blood type donors than in non-O blood type donors, among whom we observed a progressive increase from A to B and AB blood groups, with CCP AB donations comprising the highest proportion of those with a neutralizing titer ≥ 80 (Table 2).

In conclusion, although the ABO system-related effect was weaker, the results of our study are consistent with those of Hayes and colleagues [4] and support the preferential collection of CCP from non-O blood type donors, with the aim of producing CCP units with the highest anti-SARS-CoV-2 neutralizing antibody titer. High levels of anti-SARS-CoV-2 neutralizing antibodies have been clearly related to a favorable clinical effect of CCP as early treatment for COVID-19 [2]. It is probable that statistical significance could have been achieved by increasing the number of observations in our study. Further, adequately powered studies are therefore needed to definitely determine the role of ABO blood group in driving the SARS-CoV-2 antibody response in CCP donors.

Funding

None.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Focosi D, Franchini M. Clinical predictors of SARS-CoV-2 neutralizing antibody titers in COVID-19 convalescents: implications for convalescent plasma donor recruitment. Eur J Haematol 2021;107:24–8.
[2] Del Fante C, Franchini M, Baldanti F, Percivalle E, Glingani C, Marano G, et al. A retrospective study assessing the characteristics of COVID-19 convalescent plasma donors and donations. Transfusion 2021;61:830–8.
[3] Franchini M, Glingani C, Del Fante C, et al. The protective effect of O blood type against SARS-CoV-2 infection. Vox Sang 2021;116:249–50.
[4] Hayes C, Rubenstein W, Gibb D, Klapper E, Tanaka J, Pepkowitz S. Blood group O convalescent plasma donations have significantly lower levels of SARS-CoV-2 IgG antibodies compared to blood group A donations. Transfusion 2021;61:2245–9.
[5] Perotti C, Baldanti F, Bruno R, Del Fante C, Seminari E, Casari S, et al. Mortality reduction in 46 severe Covid-19 patients treated with hyperimmune plasma. A proof of concept single arm multicenter trial. Haematologic 2020;105:2834–40.

M. Franchini *
C. Mengoli
A. Ballotari
C. Glingani
Department of Hematology and Transfusion Medicine, Carlo Poma Hospital, Mantua, Italy

* Corresponding author.
E-mail address: massimo.franchini@asst-mantova.it
(M. Franchini)

https://doi.org/10.1016/j.tracli.2021.10.002